

Treatment and Prognosis of Postoperative Acute Cerebral Venous Infarctions

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Research

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Abstract

Introduction

The incidence of cerebral venous infarctions is not high, but this condition can cause serious complications. This paper summarizes the cases of serious complications after cerebral venous infarctions and proposes corresponding treatment strategies.

Methods

A retrospective analysis was performed on 5 patients that had severe complications secondary to injury or sacrifice of related veins during the resection of different intracranial lesions (cerebellopontine angle, lateral ventricle, frontal lobe, falx parietal lobe, frontal parietal lobe). There were 2 males and 3 females, aged 34-58 years. Routine CT and MRI/MRV examinations were performed before the operation, and the diagnoses were a hemifacial spasm, a meningioma of the lateral ventricle, a hemangioma, a falx meningioma and a glioma. Postoperative CT examinations were performed to understand the intracranial conditions of the patients.

Results

Five cases had injuries to associated veins, which included the cerebellar cortical vein, internal cerebral vein, middle frontal vein, straight sinus, and postfrontal vein, during the operations. There were 2 cases of venous infarctions, 3 cases of hemorrhagic infarctions, 2 cases who had conservative treatment, 3 cases who had surgical treatment, 1 case who died (the hemifacial spasm), 1 case who had a vegetative survival (the lateral ventricular meningioma), and 3 cases with good recoveries (the hemangioma, falx meningioma, and glioma).

Conclusions

Surgeons should pay more attention to intracranial vein injuries during procedures. Acute neurological dysfunction or even death may occur after these injuries. Surgeons should closely monitor the condition of the patient and proceed with surgical intervention if necessary. The prognosis is usually good for these surgery cases, but the prognosis can be poor if important veins are injured. The key to avoiding cerebral venous infarctions is to preserve the integrity of the veins to the greatest extent during the operation.

Background

Cerebral venous infarction(CVI) is a serious complication after the resection of intracranial lesions. However, due to the lack of venous valves and many anastomotic branches in the intracranial venous system, the probability of developing a venous infarction is not high[1]. Therefore, to achieve better resections of the lesions, the traditional view is that the anterior 1/3 and posterior 1/3 of the superior sagittal sinus can be sacrificed in order to bridge the vein or the sinus itself, which will not cause vein-related infarction or bleeding [2]. It has even been reported that when 63 cases of deep lesions in children were resected through the midline approach, the bridging vein in the middle-third of the superior sagittal sinus was sacrificed, but there were no venous infarctions that developed [3].

However, with the increasing difficulty of neurosurgical operations and the increasing number of operations, cases of venous infarctions are increasingly reported. The probability of a venous infarction after a purposeful

sacrifice or an accidental injury to the veins is 0.15–13%. An irreversible dysfunction or even a fatal complication can occur after an infarction [4]. The probability of infarction is closely related to the distribution of the injured veins in the brain. In this paper, we retrospectively analyzed cases of serious complications caused by venous infarctions after the resection of lesions in different locations of the brain (5 recent cases), discussed the clinical manifestations, treatment strategies and prognosis of venous infarctions in different locations of the brain, and encourage colleagues to pay attention to and protect the veins in related areas during surgery.

Methods

A retrospective analysis of 5 cases of severe symptomatic cerebral venous infarctions in the Tangdu Hospital of Air Force Military Medical University within the last 3 years was performed. Patients with mild symptoms or who had conservative treatment were not included in the study. A cerebral venous infarction was defined as a new or a larger low-density area around the tumor resection or hemorrhage around a low-density area in the brain parenchyma after the operation. A symptomatic cerebral venous infarction is defined as the occurrence of neurological dysfunction, epilepsy and a disturbance of consciousness that matches the venous infarction area[5]. There were 2 males and 3 females with an average age of 47.7 years (range, 34–58 years). Routine MRI scans and contrast-enhanced scans were performed before the operation. Some patients underwent CT and MRV examinations, including 3 cases of brain tumor (1 case of falx meningioma, 1 case of lateral ventricle meningioma and 1 case of glioma), 1 case of hemifacial spasm and 1 case of hemangioma. There were 3 cases that had lesions on the right side and 2 cases that had lesions on the left side. The approaches included the retrosigmoid approach, the lateral ventricle triangle approach, the midline approach and the frontoparietal approach. The above cases were approved by the ethics committee of Tangdu Hospital and the consent of patients or their families.

Results

Among the 5 patients, the hemifacial spasm patient suffered from cerebellar cortical vein injury after the operation, followed by cerebellar parenchymal infarction and hemorrhage, sudden respiratory arrest, and death from ineffective cardiovascular rescue (Fig. 1). The thalamic infarction patient had an injury to the internal cerebral vein during the resection of the lateral ventricle meningioma which resulted in a postoperative coma, aphasia, hemiplegia, intracranial infection, hydrocephalus, and a vegetative state after conservative treatment (Fig. 2). The middle frontal vein was injured in the frontal parasagittal hemangioma patient, and there was hemorrhage secondary to the infarction after the operation. The patient with a hematoma had the hematoma removed during the operation, and the recovery was good (Fig. 3). The multiple falx meningioma patient had lesions that invaded the straight sinus. Compression hemostasis was applied during the operation which resulted in local stenosis of the straight sinus. A postoperative hemorrhagic infarction developed secondarily. Treatments including a hematoma clearance, a decompressive craniectomy, and an intraventricular puncture were given, and the postoperative recovery was good (Fig. 4). There were multiple gliomas in the frontal and parietal lobes of the patient with gliomas, and the procedure sacrificed the posterior frontal vein, which resulted in secondary venous infarction and obvious edema. Decompressive craniectomy was performed, and the postoperative recovery was good (Fig. 5). (Table 1)

Table 1. Summary of the cases with postoperative venous infarction

No.	Diagnosis	Sacrificed/injured vein	Post-op CT	Symptoms	Treatment	Interval	GOS
2	Meningioma (left lateral ventricles)	Internal cerebral vein	Infarction, edema	Lethargy, Aphasia, Hemiparesis	Conservative	48h	2
3	Hemangioma (right frontal)	Middle frontal vein	Hemorrhagic infarction	Sober to lethargy, Hemiparesis	Operative	72h	5
4	Meningiomas (right falx)	Straight sinus	Hemorrhagic infarction	Sober to lethargy	Operative	48h	5
5	Glioma (left frontal and parietal)	Post frontal vein	Infarction, edema	Drowsy, Aphasia, Hemiparesis	Operative	48h	5

1	Hemifacial spasm (right)	Cerebellar cortical vein	Hemorrhagic infarction	Coma, Respiratory arrest	Conservative	12h	1
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GOS Score (follow-up 3 months) 5 (Good Recovery) 4 (Moderate Disability) 3 (Severe Disability) 2 (Vegetative State) 1 (Dead)

Discussion

Anatomically, the cerebral venous system is divided into a superficial venous system and a deep venous system. The superficial venous system collects blood from the cerebral cortex or subcortical area of the hemisphere and flows into the superior sagittal sinus, transverse sinus or sigmoid sinus. The deep venous system collects blood from the deep white matter and gray matter nuclei of the lateral ventricles, the third ventricle and the basal cistern, which flows into the straight sinus through the internal cerebral vein, the basal vein and the great cerebral vein. Because there are many anastomoses between the veins, a venous infarction will typically not occur after vein injury [6]. When important veins (Trollard, Labbe, etc.) are injured in a specific area, venous infarctions will occur. Due to the great variability of the venous system and the influence of the lesion on the vein, the important veins (middle frontal vein, posterior frontal vein, etc.) which would have been sacrificed in the past should be retained as much as possible after a clinical confirmation, or the decision should be made after a comprehensive evaluation. This group of patients suffered from secondary postinfarction hemorrhages due to injuries to important structures such as the internal cerebral veins and straight sinuses, as well as cerebellar cortical veins, middle frontal veins and posterior frontal veins, which have little or no anastomotic branches, resulting in serious complications and even life-threatening complications. Therefore, great attention should be given to the protection of these veins during surgery to avoid damaging the larger drainage veins as much as possible.

When the injured vein is obstructed, the blood flow velocity of its upstream vein slows down, the blood flow partly becomes retrograde, and the diameter of the blood vessel increases. Blood stasis in the blood vessel develops (unless a collateral vein provides a new drainage), and the increase in the capillary pressure in the blood vessel may lead to the increase of the permeability of the blood-brain barrier, leading to venous edema, infarction and hemorrhage [7]. These mechanisms then cause an aggravation of headache and consciousness, seizure, dysfunction, and other clinical manifestations[8].

Robertson [9] divided cerebral venous infarction development into the acute phase and chronic phase. The acute phase is characterized by severe complications that occurred in a short time after the operation and were life-threatening, while the chronic stage lasted for several days to months and presented with mild symptoms. Nakase [10] further divided the acute phase into mild and severe: mild for a gradually increasing neurological dysfunction, which was self-limiting. In severe cases, immediate neurological or conscious disturbances were found. Amey [4] divided the pathophysiological process after a venous injury into an acute decompensation period, an acute compensation period and a chronic venous reflux dysfunction period. Therefore, patients with an acute exacerbation of the original symptoms or a new dysfunction should undergo a timely CT and, if necessary, a decompressive craniectomy with a timely intervention, and patients often recovered well. However, injuries to key veins or having delayed operations for conditions such as thalamic infarctions or cerebral hernias can cause an irreversible dysfunction or even death.

To prevent cerebral venous infarctions, many methods have been reported in the literature. These include preoperative MRV, CTV, 3D vascular evaluations [11–12], and proposed peritumoral vein classification [13–14], an intraoperative cortical electrophysiological examination [15], Indocyanine green videoangiography(ICGV) to determine the degree of infarction [16], or vein reconstruction technology after vein injury [17], which would be used to comprehensively address perioperative venous cerebral infarction.

Conclusions

Therefore, due to the uncertainty and variability of the number of venous anastomoses, the key veins must be protected, and other large veins should be retained as much as possible, except after a preoperative vascular system evaluation. In cases of venous injuries, the patient's condition should be closely observed after the operation, and timely imaging examinations and surgical interventions should be carried out. With the application of multimodal monitoring and evaluation and venous anastomosis technology, the lesions can be removed to the greatest extent while at the same time protecting the venous system to ensure the safety of the operation.

Abbreviations

CVI : cerebral venous infarction:

MRI: magnetic resonance imaging

CT: computed tomography

MRV: Magnetic resonance venography

ICGV: Indocyanine green videoangiography

GOS Score Glasgow Outcome Scale

Declarations

Ethical approval and consent to participate

All procedures performed in the study were approved by the Research Ethics Committee of Tangdu Hospital of Air Force Medical University and All authors agree to participate

Consent for publication

All authors agree to publish the article in the journal

Availability of data and material

The raw/processed data required to reproduce these findings cannot be shared at this time as the data also forms part of an ongoing study

Competing interest The authors declare that they have no financial or other conflicts of interest disclosure in relation to this article.

Authors' contributions

Qing Cai: Conceptualization, Methodology, Writing – original draft. Shoujie Wang: Writing - original draft. Jiahua Zhou: Writing - original draft. Visualization, Investigation. Huaizhou Qin: Supervision. Dayun Feng: Writing - review & editing.

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Figures

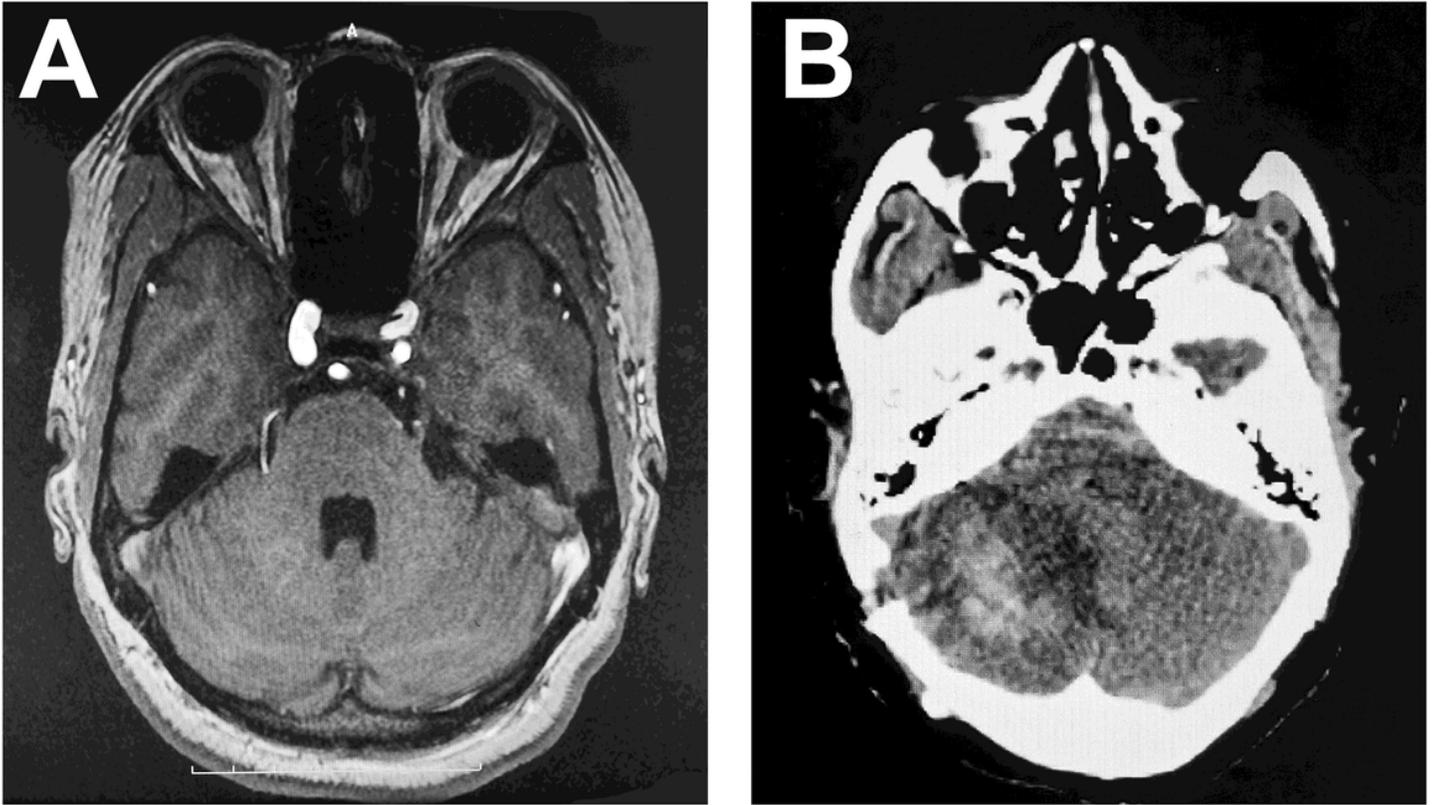


Figure 1

Postoperative hemorrhagic infarction after right hemifacial spasm operation A: Arterial compression of the facial nerve (brain stem) can be seen. B: Cerebellar cortical veins were injured during the operation through a retrosigmoid approach, and hemorrhage occurred after cerebellar parenchyma infarction.

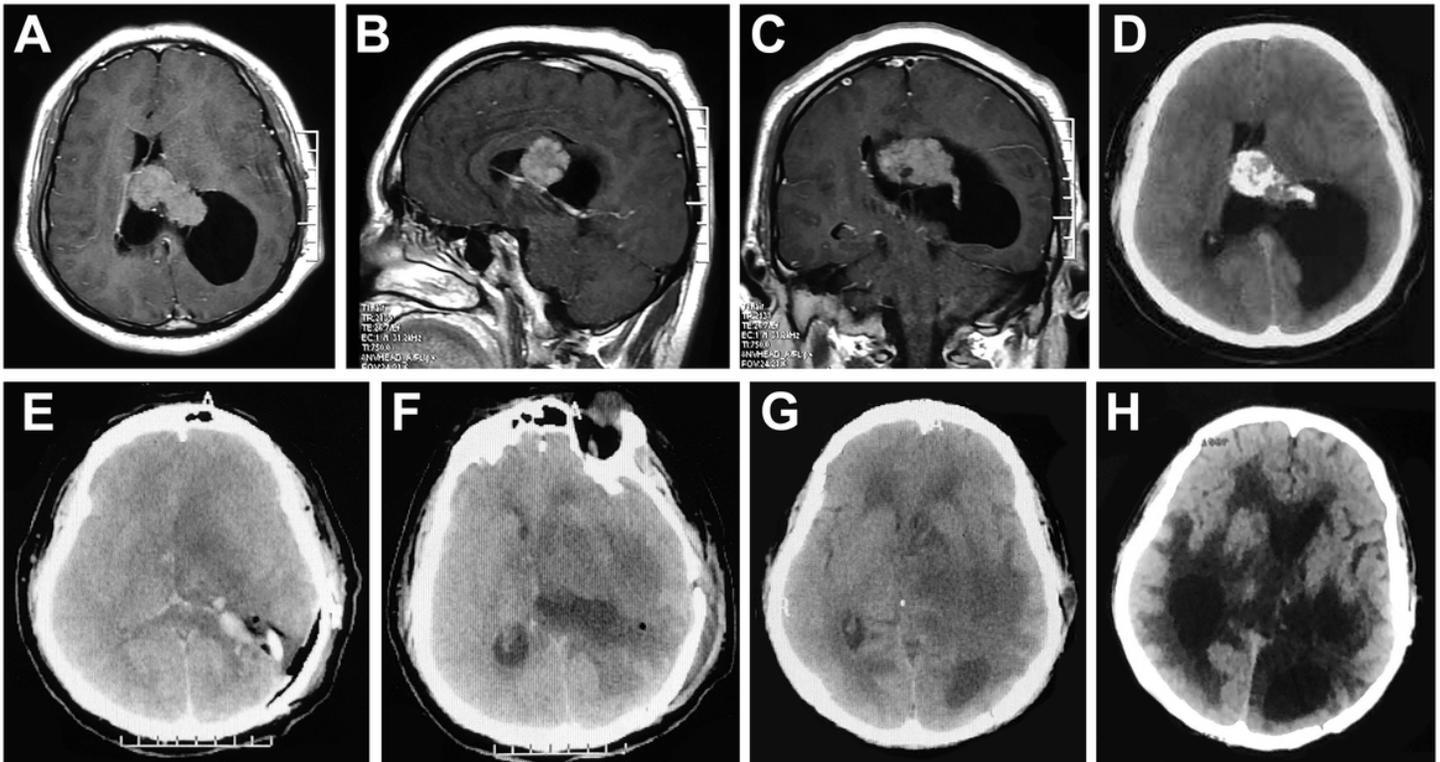


Figure 2

Thalamic infarction after left lateral ventricular meningeoma surgery A-D Meningioma of the lateral ventricle accompanied by enlargement of the ventricle and obvious calcification of the solid tumor. E: One day after the operation, a CT showed that a low-density shadow could be seen in the left thalamus, and a venous infarction was considered. F: Seven days after the operation, a CT showed that the infarct area was larger than before. G: One month after the operation, an intracranial infection caused diffuse ventricular encephalitis and interstitial exudation around the ventricle. H: Three months after the operation, the ventricular system was enlarged with interstitial exudation, and thalamic malacia had formed.

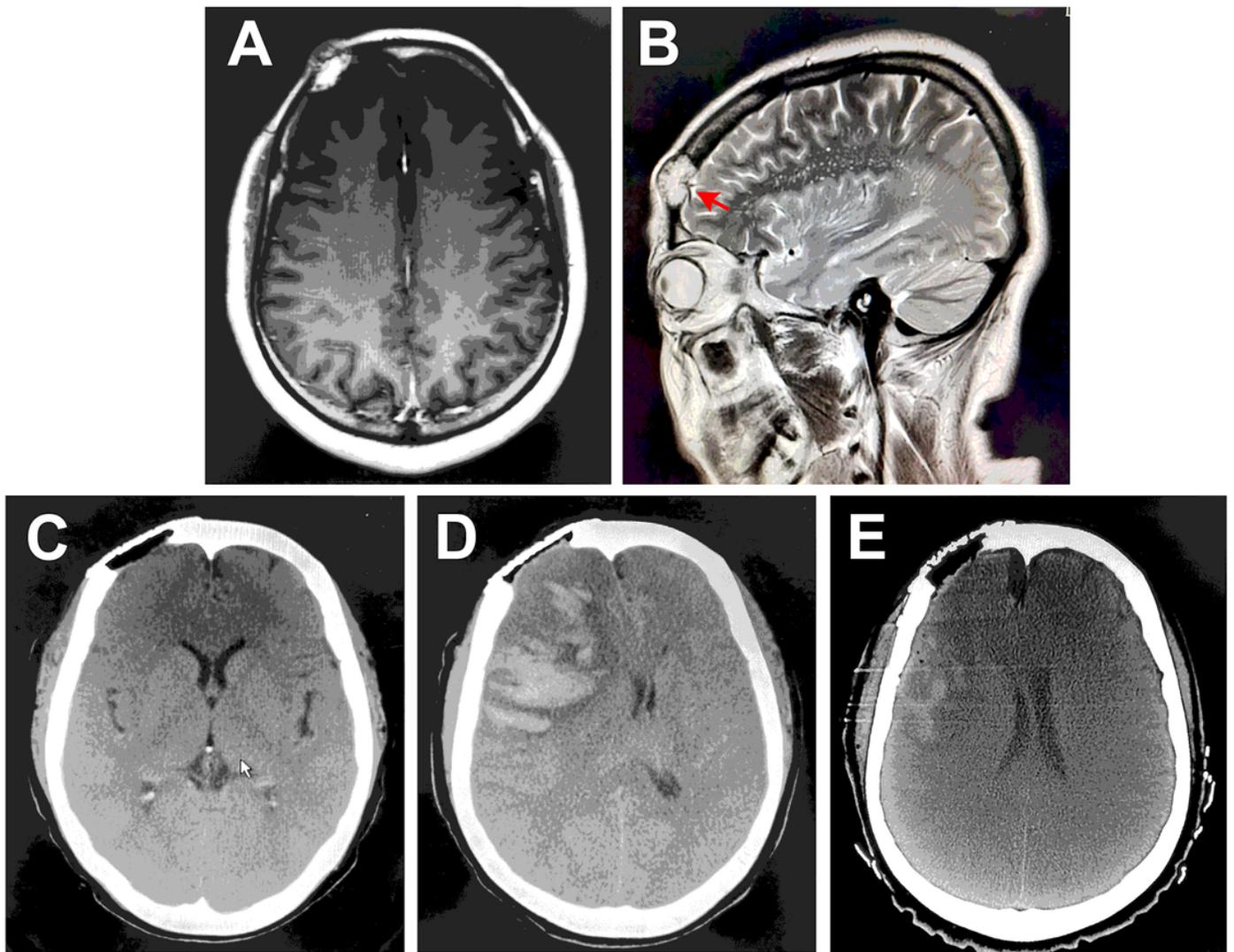


Figure 3

Hemorrhagic infarction in the frontal lobe after operation of a right frontal hemangioma A-B The circumfluence vein can be seen below the well-defined round lesion (red arrow) C Injury of middle frontal vein. One day after the operation, a CT showed that that part of the bone that invaded that skull was removed, the titanium mesh was repaired, and no abnormality was found in the brain parenchyma D Three days after the operation, a CT showed that the frontal lobe had cerebral parenchyma hemorrhage, and considering the hemorrhage after the diagnosis of a venous infarction, a deviation of the midline was then obvious E Most of the hematomas were removed and the midline was in the correct anatomical position.

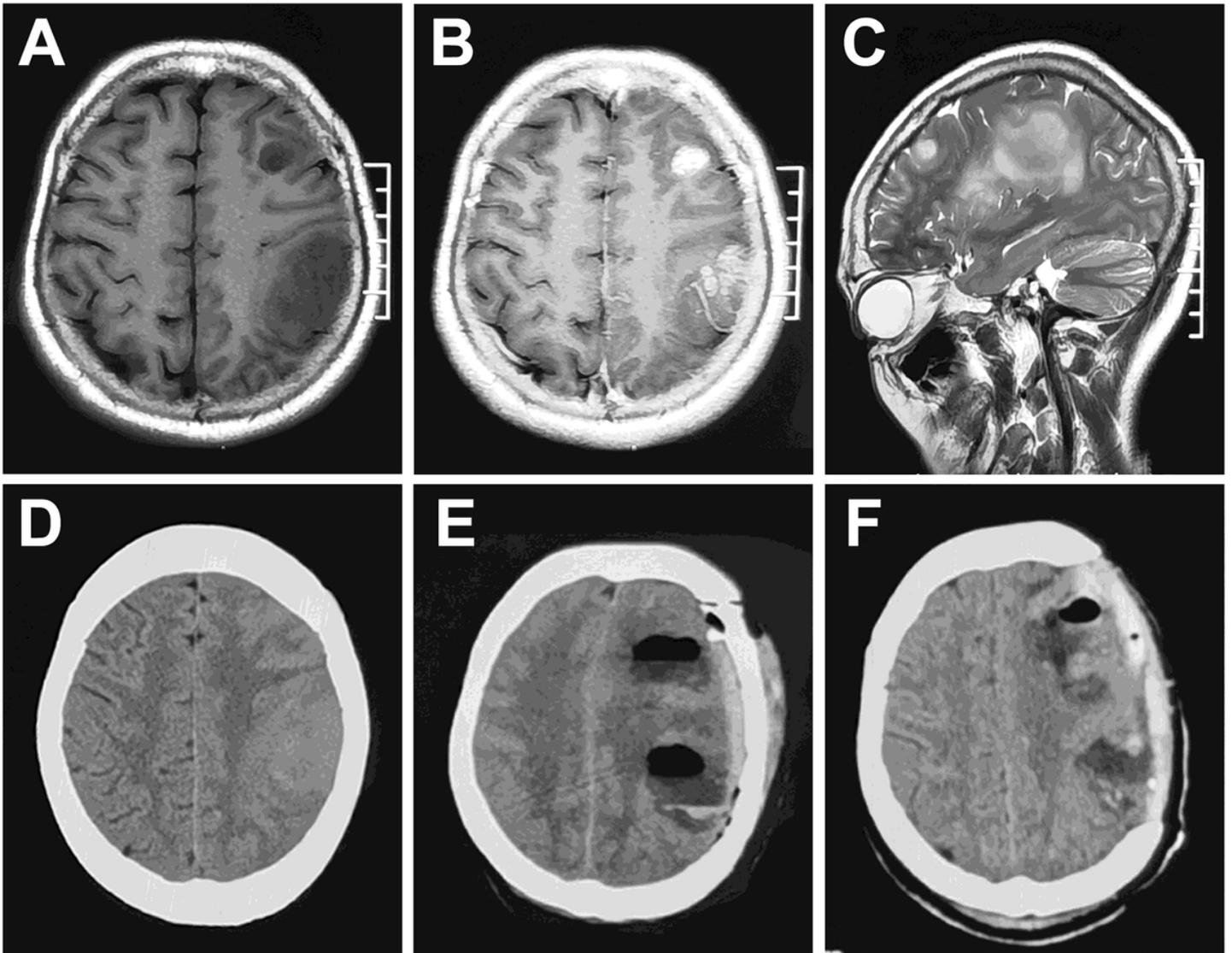


Figure 4

Hemorrhagic infarctions in multiple meningiomas of the right parietal lobe. A-D On the right side there are two obvious round lesions of parietal falx enhancement. The MRV showed The lesions invaded the sinuses, and the stenosis of the sinuses was not developed (red arrow) E The bleeding of straight sinus was obvious during the operation and one day after operation. CT showed hemorrhage after venous infarction F The hematoma was removed, a decompressive craniectomy and a lateral ventricle puncture drainage were performed.

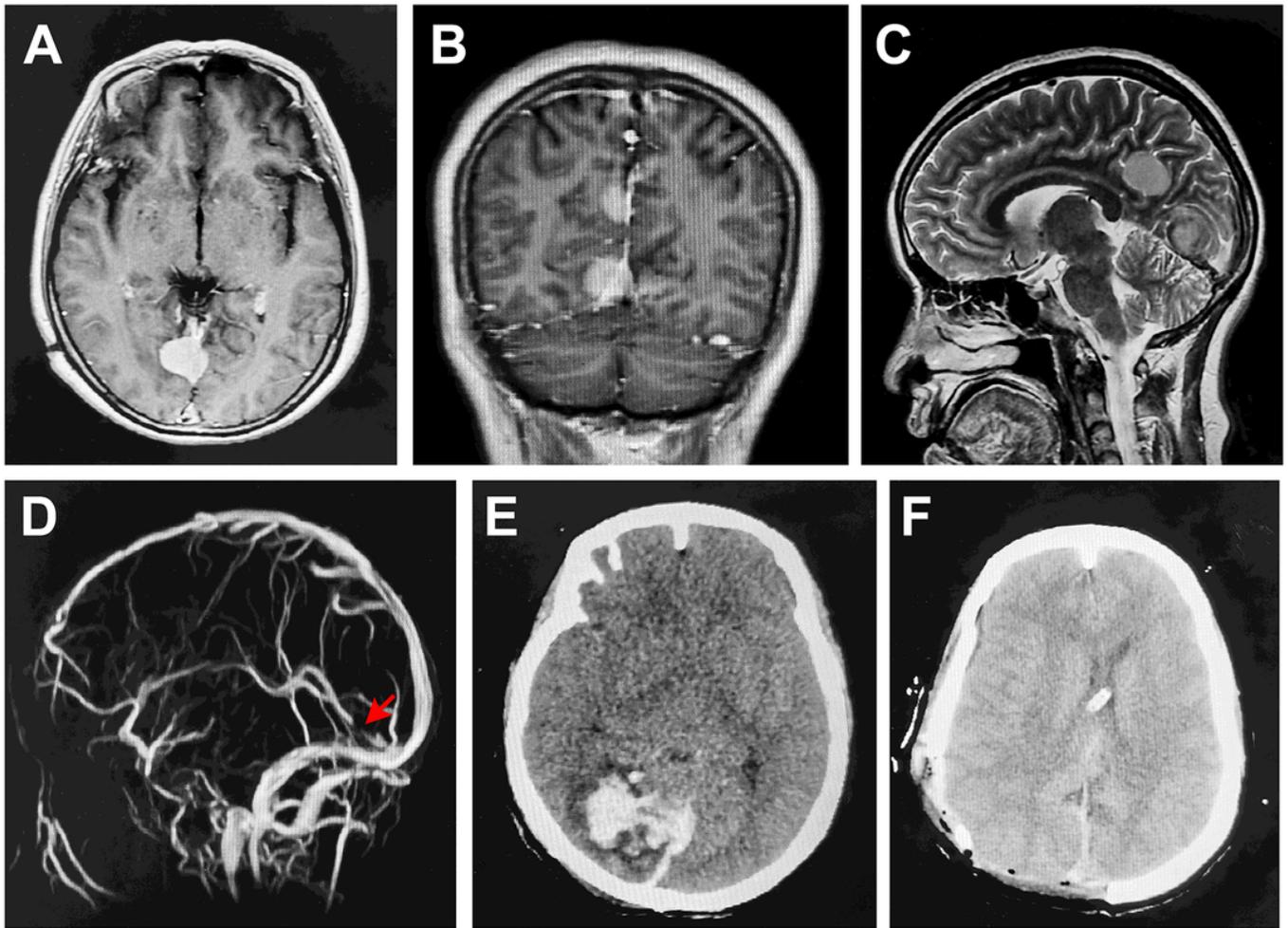


Figure 5

Venous infarction of multiple gliomas in the left frontal and parietal lobes. A-D: The lesions in the left frontal lobe and parietal lobe showed obvious enhancements. E: Intraoperative injury of the posterior frontal vein. One day after the operation, a CT showed that the low-density shadow around the lesion had increased, the midline shift was obvious, and a diagnosis of venous edema and infarction were considered. F: Three days after the operation, a CT showed that after the decompressive craniectomy had been performed, the midline was in the correct anatomical position, and the edema was alleviated.